Effect of scaffold microarchitecture on osteogenic differentiation of human mesenchymal stem cells.

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Funding Grants: A Novel Microenvironment-Mediated Functional Skeletal Muscle from Human Embryonic Stem Cells and their In Vivo Engraftment

Public Summary:
This study describes how scaffold architecture play a crucial role in osteogenic differentiation of bone marrow derived adult stem cells.

Scientific Abstract:
Design of macroporous synthetic grafts that can promote infiltration of cells, their differentiation, and synthesis of bone-specific extracellular matrix is a key determinant for in vivo bone tissue regeneration and repair. In this study, we investigated the effect of the microarchitecture of the scaffold on osteogenic differentiation of human mesenchymal stem cells (hMSCs). Poly(ethylene glycol) diacrylate-co-N-acryloyl 6-aminocaproic acid cryogels were fabricated to have either a pore network consisting of cellular, randomly oriented pores (termed 'spongy') or a pore network consisting of lamellar columns (termed 'columnar'), with both cryogel types showing a similar porosity. Both spongy and columnar cryogels supported comparable levels of cell viability and proliferation of hMSCs in vitro. However, spongy cryogels promoted osteogenic differentiation to a greater extent than their columnar counterparts, as evidenced by increased alkaline phosphatase activity and osteoblastic gene expression over 21 days post culture. Leveraging upon our previous work, we further evaluated the ability of these synthetic scaffolds in conjunction with mineralisation to promote ectopic bone formation upon subcutaneous implantation in nude rats. Mineralised spongy and columnar cryogels, both in the presence and absence of exogenous hMSCs, promoted ectopic bone formation in vivo. No such bone formation was observed in acellular cryogels devoid of mineralisation, with extensive host cell infiltration and vascularisation in columnar cryogels, and negligible infiltration into spongy cryogels. Our results thus present a novel method to tune the microarchitecture of porous polymeric scaffolds, in addition to suggesting their efficacy as synthetic bone grafts.